Research and Development for Alberta's Agriculture and Food Sector

Part I: Strategic Directions

Facilitated by

Alberta Agricultural Research Institute

Last Updated: August 31, 2000

103-00814/

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Executive Summary

Introduction

Research and Innovation are recognized as essential for the further development and sustainability of Alberta's agriculture and food industry. World market opportunities have been interpreted to indicate that Alberta's agriculture and food sector could grow substantially from its current $6.5 Billion production sector to $10 Billion and from its current value-added sector of $7.3 Billion to $20 Billion by 2010. This document has been prepared to help guide how research and innovation can help achieve the industry vision.

> **Ag Summit 2000 Vision: To create a collaborative environment which supports continued growth of a healthy, productive and sustainable agriculture and food industry in Alberta.**

Mission: **To achieve a stronger research and innovation system** that assists the agriculture and food industry to be globally competitive and environmentally sustainable with a vibrant rural economy through:

- greater focus on life sciences, environmental and value-added technologies , and
- continued emphasis on improving primary production technologies.

The research and innovation system must focus on priority areas of importance to Alberta to support the continuing market opportunities and competitiveness of the industry. Key strengths required of the system include:

- leadership, collaboration, coordination,
- internationally recognized excellence in life sciences,
- enabling technologies, such as genomics, fractionation, Information and Communication Technologies (ICT), and
- effective, adequate and strategic funding.

The research and development system must be effectively coupled to a strong innovation system that ensures knowledge and technology from research to lead to commercialization and use.

Strategic Investment Drivers

Global Competition: The agriculture and food industry is a science based business that seeks to increase efficiency, improve productivity, and diversify. **Research and innovation is essential to effectively compete in national and international markets.**

Life Sciences are the wave of the future. The agriculture and food sector, working with health professionals, has several opportunities to develop and apply new knowledge and technologies to exploit the health benefits of food to more effectively compete for national and international market opportunities. World class facilities and expertise in life sciences especially in ag-biotechnology need to be developed to capture expanding market opportunities in genetically improved crops and livestock and value-added products including functional foods, nutraceuticals, industrial ingredients and materials.

Value-adding Opportunities: There are significant opportunities expected to emerge in world markets as developing nations become more prosperous and the emerging middle class demands, and can afford, more and better quality food. The **benefits to Alberta of obtaining more value from primary agricultural products by processing and adding value** are acknowledged. The challenge is to identify markets and develop the food processing capacity in Alberta to meet the demands of, and effectively compete in, world markets.

Environmental Resource Sustainability: It is important to ensure stewardship of our natural resources and to carefully respond to consumer demands and market needs for competent management (based on scientific findings and facts) of our resources and industry wastes.

Rural Development: Strong, vibrant rural communities are an important part of the industry, the economy and the environment. Research and innovation are important elements in future rural development.

Strategic Directions

The Strategic Directions identified as the keys to future development and sustainability of the Alberta industry include:

- A highly attractive R&D and innovation system;

- New value-added technology platforms and applications;
- Increased focus on improving the human health benefits of food;
- Improving competitiveness of primary agricultural production through building innovation and sustainability; and
- Protecting and improving environmental resources.

Strategic Investment Portfolio

A shift in relative investment into strategic areas, an increase in total investment, and greater collaboration amongst the research performers and funders, are proposed for Alberta to obtain the new knowledge and technology it needs for industry growth and sustainability. Relatively increased emphasis is recommended in three focus areas: life sciences research, value-added and environmental sustainability technologies. Continued emphasis is needed in primary production technologies. An absolute increase in investment in research people and operations by all funders and performers, from **$100 million now to $250 million by 2007**, is required in all strategic areas to achieve the mission and vision.

As well, a $ 250 million investment over several years is required for infrastructure. Several advances totaling approximately $ 50 million are currently being made.

The focus areas need a **highly attractive research and development system** for sustained world-class research excellence in selected areas, complemented by an equally responsive and seamless **research and innovation system** leading to increased technology commercialization and use in Alberta. New collaborative research approaches, including formation of new centres and networks of excellence and expertise, will be needed to improve the focus and capacity of the current research and innovation system and to attract and retain leading-edge people, projects and investors.

Research and Development for Alberta's Agriculture and Food Sector

Part I: Strategic Directions

Introduction

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Ag Summit 2000 Vision: To create a collaborative environment which supports continued growth of a healthy, productive and sustainable agri-food industry in Alberta.

The future includes:

- A globally competitive agriculture and food sector which is sustainable in economic, health and environmental terms;
- An industry which provides integrated approaches to related health and environment issues;
- A market responsive $10 billion primary production sector and $20 billion value-added processing sector by 2010.

Research and Innovation Mission

To achieve a stronger research and innovation system that assists the agriculture and food industry to be globally competitive, environmentally sustainable, and contributes to a vibrant rural economy through:

- greater focus on life sciences, environmental and value-added technologies , and
- with continued emphasis on primary production technologies.

- To accomplish the mission, Alberta's agriculture and food industry needs:

- to focus its research and development (R&D) system in strategic directions to deliver new products, technologies and knowledge to help achieve the vision through;
    - leadership, collaboration and coordination;
    - creation of centres and networks of expertise;
    - internationally recognized excellence in life sciences;
    - enabling technologies such as genomics, fractionation, ICT; and
    - effective, adequate and strategic funding.

- to ensure the whole innovation system is strong resulting in;
    - commercialization and use of knowledge and technology in Alberta;
    - Alberta producers and processors effectively competing in global markets.

Strategic Investment Drivers

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Environmental Resource Sustainability: It is important to ensure stewardship of our natural resources and to carefully respond to consumer demands and market needs for competent management (based on scientific findings and facts) of our resources and industry wastes.

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elements in future rural development.

Strategic Directions

The strategic directions, based on the investment drivers, provide the **focus for key research and innovation** needed to further diversify the Alberta economy by delivering new knowledge and technologies, which will enable producers and processors within the food, fibre and life sciences value chains to **capture potential national and international market opportunities**. The key strategic directions for research and innovation are:

1. A **highly attractive research and development system** for sustained world-class research excellence in selected areas, complemented by an equally responsive and seamless **research and innovation** system leading to increased technology commercialization and use in Alberta. New collaborations and research approaches, including formation of new centres and networks of excellence and expertise, will be a key feature to improve the focus and capacity of the current research and innovation system and to attract and retain leading-edge people and projects. The three main components of the system are people, infrastructure and operating funds.

2. **New value-added technology platforms and applications** developed through research for use by Alberta's producers and processors to capture commercial opportunities in food, feed and industrial uses. Alberta must increase the ratio of value-added production to primary production, from 1:1 to greater than 2:1. This is where significant potential for economic growth is expected for the sector.

3. **Agri-health initiatives** - increased focus on improving the human health benefits of food. Interdisciplinary approach to food and human health can produce new discoveries and enhanced agriculture and food products to improve human and animal health and wellness, **food safety benefits**, prevent or reduce risk of disease, and enhance overall quality of life. Develop new products like nutraceuticals and functional foods and new and enhanced technology like proteomics, extraction and process control. This integrated multi-sector approach offers the prospect of potentially huge benefits.

4. Build on Alberta's competitive and resource **strengths in primary agricultural production and science**, by delivering leading-edge knowledge (such as information on soil and rumen microflora, and improved breeding methods) and technology to develop innovative practices and sustainable production systems and opportunity to increase value added and diversification opportunities for primary production.

5. Maintain or improve **quality of our environmental resources and vibrant rural economy**, through stewardship and use of best practices within an expanding sector, and develop leading-edge, integrated solutions to consumer and

economic issues across sectors. This may include ethical, legal, policy and socio-economic research to help avoid adverse effects on the environment and respect the needs of future generations, and to improve economy and enhance rural development in Alberta.

Strategic Investment Portfolio

The Alberta agriculture and food sector vision signals a change in direction and size. New knowledge and technology are needed to meet a more diverse and more specialized future sector.
A lead-lag relationship exists in the research and commercialization processes. The investment in R&D and innovation has to anticipate the knowledge and technology which will need to be developed and delivered to meet the future needs of Alberta□s agriculture and food sector. Investments made now by the private and public sectors will provide results and benefits in the years to come. The challenge, which we have undertaken, is to develop a portfolio of R&D investments that reflects the strategic directions identified, the key focus areas, which anticipate the future needs to achieve the agriculture and food sector vision for the future.

The investment strategy signals a need for change in focus and approach reflected in Table 1 (figs. 1A & 1B), which presents the R & D operations investment portfolio by research focus area. The current amount of $102 million annually, invested by all funding agencies, is too low relative to our competitors such as Ontario, USA, and Australia. The **recommended amount for R&D operations is $250 million annually by 2007** from all sources (ref. Growth Strategies & Research Investment in Agriculture and Food in Alberta). The public sector will need to be the catalyst.

In addition to the need for operating funds to increase people capacity and resources, there is also a need to increase physical facilities. The cost is estimated to be a total of $250 million by 2007 (ref. Growth Strategies & Research Investment in Agriculture and Food in Alberta). Progress is already being made in infrastructure investment by several organizations at a cost of approximately $50 million.

Table 1: R & D Investment Portfolio - By Research Focus Area

Research Focus Area	Current Portfolio	Recommended Portfolio by 2007	Recommended Funding Ratio- Public : Private	Link to Strategic Direction	Comments
Life Sciences Research (eg. Biotech, proteomics)	5% $6 M	12% $30 M	5:1	1,2,3	higher risk, broader benefits, and public role is key
Value Added Technologies (eg.Agri-health products, processing, fibre and new uses)	20% $20 M —— $7 B industry	28% $70 M —— $20 B industry	2:1	1,2,3	medium risk, and shared with industrial partners
Primary Production and Enhancement	55% $56 M	40% $100 M	1:1	1,4	lower-mid risk, shared with industry

Technologies (eg. Crop & livestock innovations)	------ $6.5 B industry	------ $10 B industry			and commodity partners
Environmental Sustainability/ Socio-economic Research (eg. water, soil, air, rural development, ethics, trade, policy)	20% $20 M	20% $50 M	5:1	1,5	emerging issues, multi-sector, long term, indirect benefits, mainly public role
Total - Alberta agriculture & food sector	$102 M all sources	$250 M all sources			

Life sciences research will lead to new discoveries (for example: new capabilities of soil and rumen microflora) and new platform technologies (in areas such as genomics, proteomics, bioinformatics). The benefit will be shared by many sectors - agriculture and food, health, ICT, forestry and the environment - to maximize returns and benefits to Alberta. Focusing on specific research themes, integrating research organizations in mutual projects and collaborative ventures and integrated approaches can help speed discoveries and development of platform technologies.

Value-added technology opportunities are numerous and include: fractionation, process control, extended shelf-life, logistics and materials handling, advanced materials, e-commerce, data mining, **food safety and trace back systems**, and value chain management. Nutraceuticals, functional foods, industrial ingredients, and fibre products have the potential to provide market opportunities in many new product and technology collaborations. Market opportunities include domestic and export interests in foods, feeds, food for health, fibre, ingredient and industrial materials.

Primary production and enhancement technologies are essential to **maintain and improve our strength** in primary production in a sustainable manner. Current investments in precision farming, crops, livestock, sustainable practices and niche products research areas for primary production are required and critical to meet the industry vision.

Environmental stewardship and socio-economic considerations are important components of sustainable development of the industry and the rural economy. The industry□s ability to wisely manage natural resources and wastes, and handle consumer driven issues, are important to the maintenance of a globally competitive and environmentally responsible industry. Major emphasis is needed on maintaining or improving the quality of air, water and soil. Effort is needed to develop leading-edge, integrated solutions for consumer driven and economic issues that cross sectors - related to ethics, trade and marketing policies, and rural development in Alberta.

Research and Innovation System

The first key strategic direction is a **highly attractive research and innovation system**. The caliber of the scientists, the adequacy of the facilities and access to appropriate funding will be critical success factors for implementing the key strategic directions and the research focus areas. The best expertise will be needed to lead specific research focus areas to enable Alberta to build resources and achieve new breakthroughs within shorter time frames.

Alberta has a capable, collaborative and responsive agriculture and food research and development (R&D) system that has served the agriculture and food sector well. The Alberta agri-food research and development system has many strengths which help the sector meet some of the global market opportunities. Past investments indicate tremendous returns to Alberta from all levels of the value chain.

Alberta has a large land base for diverse the agriculture and food industry. Geographically there are eight widespread Research and Development locations with larger activity and at least as many with smaller activity. This is the most decentralized research resource in any province creating challenges for communication and coordination.

The total agriculture and food R&D investment in Alberta from all sources was about $102 million in 1998/99. The source of funds was 78% from public sector and 22% from private sector. Agriculture and food R&D in Alberta was funded primarily by:

- Alberta Government Departments and agencies,
- Federal Government Departments and agencies, and
- Industry (a variety of companies and agricultural an food sector organizations).

Agriculture and food R&D in Alberta is carried out at a variety of facilities, which are mostly public sector:

- Agriculture and Agri-Food Canada, (44%)
- Universities of Alberta, Calgary, and Lethbridge, and some Colleges, (24%)
- Alberta Agriculture, Food & Rural Development, and Alberta Research Council, (24%)
- Industry (11%).

*(**Note**: The numbers above in brackets indicate the percent of research funding performed. Public sector facilities conduct 89% of the research funding invested annually.)*

The current **research and innovation system faces new challenges** and will need to adjust to meet the 21st century's needs and opportunities. The system has to expand over time to achieve the critical mass **to be world class in selected focus areas**. The convergence of technologies and scientific disciplines is an opportunity ready for development. The expanding industry in Alberta needs state of the art R&D support to compete effectively.

Alberta has nationally and internationally recognized R&D expertise in many areas (Table 3). However, research and innovation competencies need to be up graded to develop a world class science base in the emerging priorities of **environmental, life sciences, and value-added enabling technologies**. This is a fundamental requirement for developing and supporting an environmentally sustainable agriculture and food industry.

New and aggressive investment will be required to meet the industry's ambitious vision. The investment will help to improve and enhance the R&D and technology development infrastructure, the caliber of scientists and knowledge. The investment strategies should lead to increased investment by industry partners.

Research and Innovation System - Options to Improve

To achieve the Ag Summit 2000 vision, Alberta research and innovation system partners need to jointly embrace the vision and work together and coordinate their R&D efforts and their roles. This will help to ensure the competitive position of the industry in national and international markets. The sector vision and strategies also need to be aligned with the overall provincial vision and R&D strategy, especially the Life Sciences Strategy. To provide the required support, the current research and innovation system has to be improved to create the required critical mass through:

- increased people capacity
- increased physical infrastructure, and
- creating networks, centres and restructuring.

A. People Capacity

Increased scientist and technical capacity will be required, particularly in the priority areas. Programs such as Canada Research Chairs, Alberta Heritage Fund for Science and Engineering Research, and the Alberta Heritage Fund for Medical Research have the potential to support researchers, particularly at universities. As well, government and industry research performing organizations should be encouraged to invest more to increase people capacity. Educational institutions should take steps to increase graduate student agri business management and technical training.

B. Physical Infrastructure

New physical resources will need to be obtained by research performing organizations through their budget processes, through industry assistance, or through national and provincial programs for universities. The Research and Development system will benefit greatly from improved electronic communication infrastructure.

C. Networks, centres and restructuring

Most stakeholders support the need for increased collaboration and creating new networks which have formal structures. Stakeholders support creating **centres of**

excellence or **expertise** or **research networks,** or a combination thereof. Stakeholders also support the transfer of resources and responsibility from several organizations to a single one. Research investments will be made by different players in the Alberta system aligned with the strategic directions for research and innovation. Collaboration within and between centres and networks will be essential. AARI should provide leadership to facilitate the interaction required.

Several research organizations currently address similar topics or areas of research (see table 3). There is a need to evaluate the potential for restructuring similar areas into centres of excellence or expertise with streamlined management.

Research and innovation agencies located in Alberta and western Canada will need to coordinate and align their research goals to meet this aggressive agenda. Criteria to consider in priority setting include: risk/return of the research investment; infrastructure, research investment levels and timing; current investment mix; science and technology personnel, and collaboration approaches to minimize duplication.

D. Innovation system

A much stronger innovation system is needed. Some successful models, developed and employed by Kansas, Austin and others, to start new industries and sustainable industry partnerships need to be closely examined. This □systems□ approach includes agreements with university partners, creation of incubators for new spin-off companies, development of venture capital corporations and industry partners for commercialization. This approach moves the research and innovation system into a strong public-private partnership in an integrated and sustainable manner. Two models were prepared for discussion to enhance the Alberta research and innovation system and are developed for consideration. (See Part II, Fig 2 and 3).

The need for a stronger system is one that is shared with other sectors and initiatives of the
Alberta Science and Research Authority will be important in addressing the needs.

Strategic Investment by Technology Development and Commercialization Continuum

The investment strategy also considers investment allocations according to the technology development and commercialization continuum. Table 2 (also see fig 2) provides the current levels of investment by R&D and commercialization stages in Alberta. It is expected that more emphasis will be placed on the development of technology and products which will effectively be commercialized. The allocation of strategic investments by continuum has not been determined.

Table 2: R&D Investment in Alberta by Technology Development and Commercialization Continuum

R&D & Commercialization Stage[1]	Operating $ Millions 1998/99	Percent of Investment 1998/99	Percent of Recommended Investment 2005/07	Recommended Funding Ratio-Public : Private 2005/07
Basic Research	16.3	14		
Applied Research	51.2	45		
Technology Development	20.9	19		
Technology & Knowledge Transfer	17.2	15		
Commercialization & Utilization	4.1	4		
Unallocated	2.9	3		
Total	112.6[2]	100		

Notes: 1: *See Appendix A for definition of Stages*

2: *This value is greater than $102M in Campbell 1999 report because additional investment in commercialization has been identified.*

3. *It is recognized that the data is understated relative to industry investment and some related government investment in the areas of Technology and Knowledge Transfer and in commercialization and utilization.*

Table 3: R&D Organizations and Areas of Expertise in Alberta

Organization	Areas of Expertise
Agriculture and Agri-Food Canada-AAFC Research Centres, Lethbridge and Lacombe	**Animal Sciences**: beef production, cattle genetics, rumen microbiology, feed biotechnology and nutrition, livestock parasitology/insects/pests, animal behaviour, livestock processing, meat quality and safety **Crop Sciences**: agronomy, crop breeding and pathology (cereals, canola, potatoes, beans, forages), biocontrol of weeds **Microbiology**: molecular genetics and biology **Renewable Resources Management**: soil/air/water quality, soil conservation, manure management
Alberta Agriculture, Food and Rural Development-AAFRD	**Livestock:** production practices **Crops**: crop breeding and pathology (cereals, canola), minor/special/horticultural crops, farm machinery. **Value-added processing** and product development **Renewable Resources Management**: irrigation management, soil/air/water quality, soil conservation, manure management
Alberta Research Council-ARC	**Animal Sciences**: animal health care products, vaccines, biotechnology & effect of pollutants on livestock (toxicology) **Crop Sciences**: integrated weed & pest management, biocontrol, specialty, native & transgenic crops development **Renewable Resources Management**: greenhouse gas mitigation, air emissions, waste and landscape management, aquaculture and water treatment **Bioinformatics**: data mining, system development & management
University of Alberta	**Animal Sciences**: dairy, beef, swine and poultry production, cattle genetics, feed biotechnology and nutrition, livestock parasitology/insects/pests, animal behaviour **Crop Sciences**: agronomy, crop breeding and pathology (cereals, canola, forages and vegetables) **Food Science**: Value added processing, product and process development, food safety and quality **Microbiology**: molecular genetics and biology (biotechnology) **Renewable Resources Management**: soil/air/water quality, soil conservation, waste management **Rural Economy**: resource and production economics and marketing
University of Calgary	Plant biotechnology, vaccine development and health linkages with agriculture production and food safety
University of Lethbridge/AAFC	Proteomics, beef production
Olds College , Centre of Innovation (OCCI)	Horticulture, composting and agri-equipment development

Strategy Development Process

In March 1999, the Strategic Committee of the Board of Directors, Alberta Agricultural Research Institute (AARI) commissioned a consortium of consultants led by S. J. Campbell Investments Ltd. They were asked to:

> a) investigate and prepare a report on the current status of R&D system supporting the agriculture and food industry in Alberta, and
>
> b) develop recommendations on the future improvements and expansions of the R&D system which will be required for supporting the industry to respond to market opportunities and become a $10 billion production sector and a $ 20 billion processing industry.

The Strategic Committee also organized a one-day R&D workshop (April 11, 2000) which met the needs of both the strategy development and the Ag Summit 2000 process for the R&D topic. The workshop obtained input from a wide range of stakeholders from both the public and private sectors. The AARI Board reviewed the outcomes and established a Strategic Task Force to continue work with the agriculture and food industry to help further develop □Strategic Directions" for the industry in Alberta.

The Strategic Task Force and the Ag Summit R&D representatives met July 19, 2000 to review the outcomes of the Ag Summit process and related reports. This lead to a revised draft of the Research and Development Strategic Directions for Alberta's Agriculture and Food Industry Sector. A second Stakeholders workshop was held on August 3, 2000 to obtain input and to confirm the strategic directions for industry research and innovation.

After many drafts, this document is the result.

The August 3 workshop also started to examine the basis for collaborative implementation, which is being developed in Part II - Turning Strategy into Action.

To provide comments or get more information, please contact:

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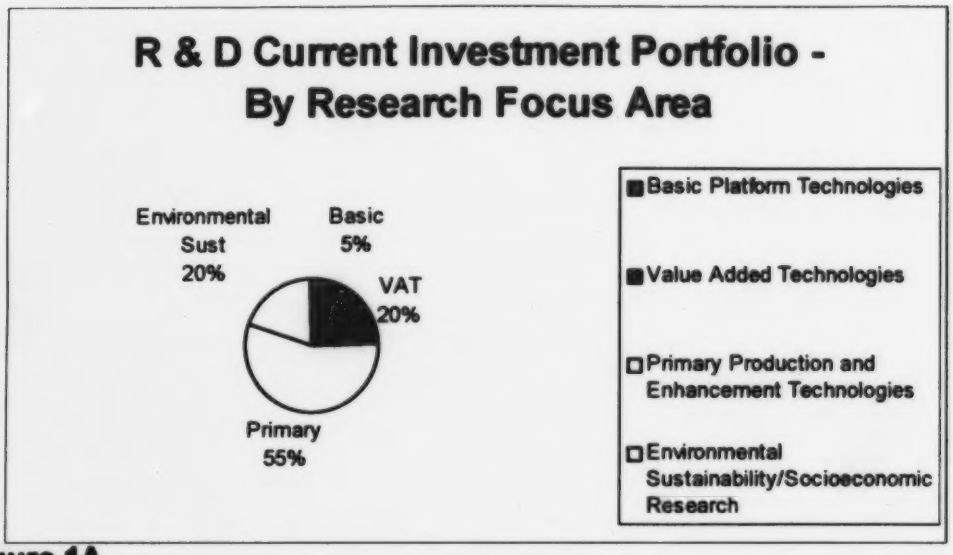


Figure 1A

Figure 1B

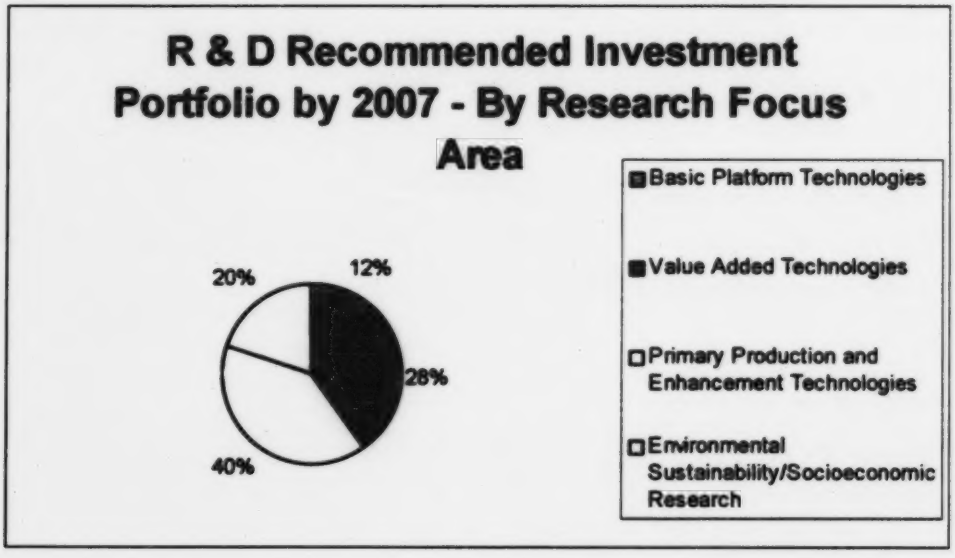
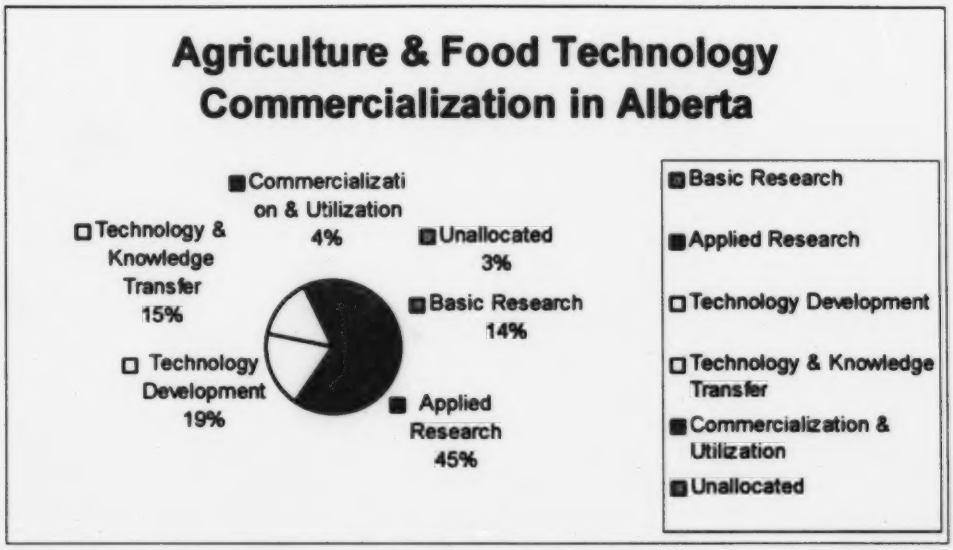


Figure 2



Distribution of 1998/99 Alberta Investment in Agriculture and Food R& D and Commercialization by Technology Continuum, from all sources (Campbell, July 2000)

Appendix A

Definition of Stages (Continuum Categories) used in Table 2

Basic research - understanding how things work. Examples include the discovery of a new disease resistance gene, report of a new composition of matter, or demonstration of a new mode of action. The work will normally become the subject of peer reviewed scientific publications or patent applications. These publications should most often represent the first disclosure of new knowledge, whether made public or not. The specific commercial or non-commercial use of the discovery may be uncertain and the benefit of the discovery uncertain.

Applied research - application of basic findings to potentially useful purposes. Includes work to validate newly reported discoveries through independent study and report it in peer reviewed scientific or proprietary literature. Includes work to characterize and extend a new discovery, including scientific work to support utility and process patents related to an earlier discovery. Includes research to demonstrate the food, feed and environmental safety of a new trait.

Technology Development - using basic and applied knowledge to develop specific technology. Examples are plant breeding to transfer traits to regionally adapted varieties with commercial potential. Variety registration trials. Research to demonstrate food, feed and environmental safety of a candidate variety or product. Pilot plant processing of new varieties and species that might be produced in Alberta.

Technology and Knowledge Transfer - process of moving new technology and knowledge to potential users. Examples include work to conduct variety recommendation trials or evaluate the utility of a new technology, process or product for commercial or non-commercial use. Includes proof of concept work to support an early-stage decision to attempt to commercialize a technology new to Alberta. Evaluation of technology developed elsewhere (outside Alberta or outside firms active in Alberta) for use in Alberta. Pilot plant work to establish and validate state-of-the-art process design parameters for new construction.

Commercialization and Utilization - process of making new technology and knowledge available for commercial or non-commercial production and distribution. Examples includes pilot plant work to reduce a new technology to practice; on-farm or in-plant demonstrations of new products or procedures; or work to establish technical requirements for seed multiplication and establish new identity preservation systems. Work to demonstrate the utility and social and economic benefits of a new technology, product or procedure to users and society.

Unallocated - Work not elsewhere specified but pertaining to □new□ technology or maintenance of an established technology subject to a current regulatory review. Work includes development of standard methodologies for regulatory or trade requirements and sample preparation at a pilot plant for customer or regulatory evaluation prior to commercial production.